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Moving from a catching up position towards international leadership: lessons from the coffee sector in Costa Rica

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Abstract

The contribution of any specific sector to the development of a country evolves along the time. In some periods a country can move from a catching up towards a leading position with respect other countries. The factors explaining this change of position is related to the evolution of the system of innovation. This kind of phenomena has been studied by different authors using an approach of sectoral system of innovation. This paper presents a study on the evolution of the coffee sector in Costa Rica, assessing the main innovations in different stages of development and the evolution of the sectoral system of innovation. The research project was based in a literature survey complemented by interviews to experts and actors in the sector, and with the analysis of data bases. The main argument is that there are different stages of development of the coffee sector, in which the role of the main dimensions of the sectoral system (institutions, specific actors, networks, agglomeration economies, human capital, and learning processes by firms) have evolved, giving the condition to relevant institutional and technological innovations. The sector changes from a catching up position for many years towards a leading position in the last decade. A result is that Costa Rica is passing from exporting coffee as a raw product to export intensive knowledge coffee, in which R&D and several institutional innovations results in the specialization on high quality coffee with one of the highest productivity in plantations in the world.

Key words
Innovation, systems of innovation, catch up, coffee sector.

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1. Introduction

The analysis of development in a specific country is clearly related with the evolution of some key sectors. The leading sectors normally differ in distinct countries and the processes in which the same sectors in different countries catch-up, may also present different trajectories. The contribution of the sectors to the development of the countries can also differ according to specific characteristics of the evolution of the sector. In the case of Costa Rican economy, the coffee sector has played a very relevant role for a long period. The sector has evolved along the time. It is possible to identify several stages, in which distinct innovations emerged, thank to the development of the system of innovation.

The objective of this paper is to study the evolution of the coffee sector in Costa Rica, assessing the main innovations in different stages of development and the evolution of the sectoral system of innovation. The basic research questions that the paper is trying to answer are: how do different dimensions of the sectoral system (institutions, specific actors, networks, agglomeration economies, human capital, and learning processes by firms) have evolved and have determined the development process of the sector?

The research project was based in a literature survey complemented by interviews to experts and actors in the sector, and with the analysis of data bases. The study of the trajectories of the sector is based on a sectoral innovation system approach (see Malerba F, 2004). This means to put emphasis in the trajectories of three different issues: the knowledge base, the actors and networks, and the institutions. The *Knowledge and technological domain* is relevant because any sector could be characterized by a specific knowledge base, technologies and inputs. As argued by Malerba, in a dynamic way, the focus on knowledge and the technological domain places at the centre of the analysis also the issue of sectoral *boundaries,* which usually are not fixed, but change over time.

The dimension of *actors and networks* is also relevant. Actually, a sector is composed by heterogeneous agents, both organizations and individuals. Organizations include both firms (e.g. local firms, subsidiaries of multinational corporations, users, producers and input suppliers) and non-firm organizations (e.g. universities, financial institutions, government agencies, or technical associations), including sub-units of larger organizations (e.g. R&D or production departments) and groups of organizations (e.g. industry associations). Agents are characterized by specific learning processes, competencies, beliefs, objectives, organizational structures and behaviours. They interact through processes of communication, exchange, cooperation, competition and command. In a sectoral system framework, innovation is considered a process which involves systematic interactions among a wide variety of actors for the generation and exchange of knowledge relevant to innovation and its commercialization. Interactions include market and non-market relations that are broader that the market for technological licensing and knowledge, inter-firm alliances, and formal networks of firms, and often their outcome is not adequately captured by our existing systems of measuring economic output. *Institutions* are key factors, because agents' cognition, actions and interactions are shaped by institutions, which include norms, routines, common habits, established practices, rules, laws, standards and so on. A lot of institutions are national, as for example the patent system, while others are specific to

sectors, as for example the sectoral labour markets or sector specific financial institutions (taken from Malerba, 2005).

One issue in the analysis is on the role of sectoral systems of innovation on the performance of the sector. The role of the systems of innovation on performance is derived from their role on innovation processes, especially on the fact that innovation is an interactive process. Edquist (2001) argues that the most important function of the systems of innovation is to produce, diffuse and use innovations. The relationships between institutions and organizations in a system of innovation influence innovation processes and thereby also the performance of the system (Edquist and Johnson, 1997).

The role of the systems of innovation is strong even in particular firms. Actually, firm efforts and competencies are supported and shaped by the system or, as Nelson has pointed out, "what firms do, and the technologies they employ and develop, are influenced to a considerable extent by the environment they are in" (Nelson, 1998: 512). A similar idea is presented by Cimoli (1998), arguing that the interactions between competencies (referring to a firm, organization or country abilities to solve both technical and organizational problems) and performance (as measured by variables such as competitiveness and contribution to industrial growth) are shaped by the systems of innovation. He also argues that economic performance depends on how each country implement policies and organizes its institutions, which are also part of the system of innovation. Some other studies emphasizes that growth and catch-up potentiality are clearly related to a country's historical path and to the development of the systems of innovation (Katz, 1997).

The production of coffee was introduced in Costa Rica in 1804. The country began exporting coffee in 1832, very soon after its independence. This product has linked the economy with international markets through exports to different countries. There has been relevant transformation in the institutional framework, and in the role of different actor along the time. It is possible to identify also relevant technological changes both, in plantations, transport system and processing methods. There are different stages of development of the sector, in which the role of the main dimensions of the sectoral system (institutions, specific actors, networks, agglomeration economies, human capital, and learning processes by firms) have evolved, giving the condition to relevant institutional and technological innovations. In the paper we analyze the main innovations in the sector. There are also some arguments explaining how these innovations were determined by the sectoral system of innovation.

The way in which the coffee sector is organised is dynamic in terms of both the technical and the social organization of interlinkages among cultivation, harvesting, local transportation, processing, overseas transportation, and distribution abroad. In general, the nature of the international coffee market has changed significantly over the centuries. The control of the market moved away from producers to exporters in the eighteenth century. Later on, in the nineteenth century the control was taken by importers and in the twentieth century to roasters, government institutions, and finally to few vertically integrated multinational firms (Samper, 2001). This kind of transformation has generated relevant changes in the sectoral systems of innovation in the sector. There is information about the trajectories of three different issues: the knowledge base, the actors and networks, and the institutions. The evolution of the

institutional framework is explained highlighting the main changes in the policies and the sectoral organizations.

There was a very relevant institutional innovation about 1920 -1930, when is developed a sectoral organization (IDECAFE), which defined new regulations, giving the space for a faster expansion of plantations and better conditions for the emerging exporter sector. During the decade of 1960 the sector introduces technical changes to improve productivity, based on the intensive use of agro-chemical inputs and new varieties of coffee trees.

The emerging cooperatives in the sector marked a strong change from the decades of 1960 to 1990. These organizations generated relevant changes in the market structure, giving better conditions to the farmers. There is also a big effort in R&D in this period, which results in important increments in productivity. Actually the coffee sector in Costa Rica has one of the highest productivity in the world. Some institutional innovations separate the farm activities and the processing of the grain, which result in better quality and higher prices. From 1990s the sector introduce several changes: the emerging of quality niches, a growing relevance of the local market, some innovations in the commercialization mechanisms, lower scale processing factories, and the introduction o environmental regulations. There are two main innovations aimed to improve the environmental performance of the coffee sector. The first ones is the modernization of coffee factories, which allowed these companies a minor utilization of water and energy. The Inter-institutional Agreement for Cooperation among producers and authorities was the motivator of this innovation. The second innovation came from relevant changes in the environmental legislation developed in the country, which aimed a rational use of water and energy in a framework for the introduction of the cleaner technologies.

One relevant conclusion is that Costa Rica is passing from a long catching up position towards an international leadership in the sector. From exporting coffee as a raw product the country has move to export intensive knowledge coffee, in which R&D and several institutional innovations results in the specialization on high quality coffee with the highest productivity in plantations in the world.

The key actors in the knowledge base of the sector have changed along the time. When the coffee sector began developing in Costa Rica, most of the knowledge base was developed by foreigners, especially from the importer countries. In the first phase, the State gave different incentives and basic support to promote the cultivation of coffee. But later on, the State has had a growing contribution to the knowledge base, promoting R&D along both in the cultivation and in the processing phases of the production chain. The diffusion of knowledge has been a function mainly of State organizations but from the 1960s also of the cooperatives of farmers. The universities have had a poor contribution both in generation and in diffusion of technological knowledge. The knowledge on markets and marketing strategies was concentrated mainly in importer countries, but the incursion by ICAFE in these issues, and the direct participation of the cooperative sector and other exporters, has also contributed to generate local expertise.

Networking has also evolved. The kind of interaction among farmers and processing mills changed along the time. From the decade of 1920s, the State has played a role regulating these interactions, especially for the definition of prices. From the 1990s,

new kind of interactions was possible thanks to coordination among governmental and non governmental organisation among them and with the different actor along the production chain.

Financial mechanisms were very limited for many decades, depending on payments in advance from the importers to the exporters and from them to the rest of actors downstream. But early in the XX century the State had a growing participation through national banks.

We can argue that Costa Rica has become a leader country in many technological issues. The continued investment in R&D to improve the different phases of the production chain made the country leader in several technologies that improved the performance of the sector. The country has also developed in some other technological components by adapting, debugging and improving technologies and competencies developed in some other countries. But still so, is reasonable to argue that Costa Rica is a leader country in knowledge generation for the coffee sector. The strategy to concentrate in high quality and well paid segments of the market is a good indicator of that. One of the highest productivity in the world in plantations is also a good indicator of the leading condition of the country.

2. Evolution of the Costa Rican coffee sector: a chain international perspective

The production of coffee was introduced in Costa Rica in 1804 by Governor Tomás Acosta. The country began exporting coffee in 1832, only nine year after getting its independence in 1921. The main objective was to get stable connection to international markets. Because of that, the production of coffee was stimulated with different instruments, mainly in small areas. Promotion policies to increase production areas and public investments in infrastructure made it possible for the country to export coffee. The road to Puntarenas, where it is one of the main harbours in the country was finally built and Costa Rica became a regular exporter of coffee to England in 1844 -1845. As a result, important social and economic changes took place.

The regular link to international markets through coffee exports came to consolidate agrarian capitalism in Costa Rica (Acuña and Molina, 1991: 90). A coffee oligarchy then emerged and enjoyed the political governance of the Republic since its beginning in 1849 to up the middle of twentieth century. A very relevant characteristic of coffee production in Costa Rica, is that this product from the beginning stimulated high economic and social linkages in the country. This was an important difference respect to banana production, the other main product introducing to Costa Rica in an agro-export model, which was an enclave, for long extent isolated from the rest of economic structure.

The evolution of the sector was determined mainly for international conditions. Historically the input - output system was organised in such a way that colonies earlier and new republics later were in charge of providing raw materials (coffee green) while imperial and industrialised countries later run the international commerce activities and industrialisation. The colonisation process expanded coffee production from sylvan in Ethiopia and Sudan, to Java-Ceylon and Antilles Sea. Slave labour first was used in Saint Dominge (a French colony) to boost it, but it was later spread to other Caribbean

areas such as Central America and Brazil, during XIX century. During the second half of that century Brazil became the dominating exporter to international markets.

Excess of supply appeared during 1896-1908 associated to the impact of the Brazilian production. The agriculture profitability was related to extensive production based on low cost technology and increasing prices resulting from increasing consumption (Samper, 1994: 17). Two periods could be distinguished: the extensive production period and the intensive growth period. The historical break point between these two periods could be established in 1960 when new technology introduced in Kenya and Costa Rica was adopted by Brazil and Colombia (Daviron, 1994: 42-43).

The first multilateral supply restrictions, supported by Brazil, were introduced during the first decades of the XX century, (Samper, 1994: 17-18). This brought contradictory effects because those restrictions could not prevent price reductions. They also helped to establish negotiations between grower and consumer countries, on one hand, what stimulated increasing growing areas in Africa, Asia and Latin America on the other hand. Since the second half of the XX century, the world's production has increased faster than coffee exports. It has been so because the growth of domestic consumption (13% in 60´s, 18 % in 70´s (Samper, 1994: 19, De Graaf 1986: 31) has been higher than the lower growth of USA and Europe's demand, partially compensated only by the growth of the Japanese and Korean markets.

Business cycles in the international market of coffee have lead to changes in the governance system, arising from the dispute of strategic rents between coffee grower and consumer countries. On a firm basis, private agents have being operating and shaping their model of organisation and concentrating market controlling power. Daviron (1994: 49-71) provides a kind of analysis that let us to trace the general changes in the governance system. The first most influential agent of the chain were the American and European Commerce Houses. They arose among a multitude of growers, middle agents and coffee small roasters. Daviron calls this period *commerce houses oligopoly*. These agents obtained their influential position as they provided warehousing function, which let them influence international prices[2]. It meant the presence of a supply driven chain.

A strategical dispute emerged as Brazil became the biggest supplier of coffee green. This country started developing its warehouse capacity from 1906 to 1927 in order to establish a supply side control. Daviron distinguishes how a second period, the *Brazilian monopoly* period covering the period 1930 - 1958. Brazil then assumed the role of "residual supplier" intended to keep its exports as the difference between world imports and world production. This position however, was eroded as other countries increased their participation in international markets, particularly Colombia that did not accept to share the cost of a market stabilisation program[3].

During that period the consumer countries showed two different trends, called market fragmentation by Daviron. First, during the Second War the United States became a

[2] At the end of XX Century Brazil produced 75% of world production, and the first commerce houses controlled 71% of exports, and the first five 53% (Daviron, 1994: 49)

[3] Brazil intended to have co-operation from other Latin-American countries, mainly Colombia, in the context of 1929 crisis, but it was not successful. (Daviron, 1994:50)

monopsonist to Latin-American sellings. This made the USA able to lead an international agreement between grower and consumer countries. In 1940 USA and Latin American countries signed a Latin-American Agreement which established export quotas to USA.

Second, the European imperialist strategy established discriminating mechanisms against imports. France developed the most important change through shifting the consumption from Arabica coffee to African Robustas in a period of 25 year (1930-1957). This made Africa able to increase its participation in international markets.

As a result of the tendencies mentioned above, it could be distinguished a third period, the *co-operative oligopoly period* (Daviron, 1994: 53). It is associated to the consolidation of the International Agreement (ICO) in 1962, constituted by grower and consumer countries. This agreement was based on: i- The existence of a unified market; ii- The co-operation between countries was based on similar export policies; iii- Brazil continued to play the role of residual supplier, and iv- The agreement worked based on the evolution of traders and coffee industrials. Commerce Houses and Roasters lost their position in the chain in favour of traders and industrialised companies. From 50's emergence of big food industries took place as part concentration process. It was more evident in the soluble coffee segment where Nestlé and General Food came to share the world market.

By this way a new centre of governance was emerging in the international chain, related to the appropriation of monopoly rents. During the 60's and 70's TNCs relied on ICO's rules to secure a favourable economic environment for its optimum growth. Later, other events weaken ICO´s rules and strengthen market mechanisms.

The trends shown prior to the crisis of 1989 suggested another changes in the governance structure of the chain. On the supply side Brazil was losing its market share due to quotas allocation promoted by ICO. Besides an extra market quota emerged where better prices were paid. The market assigned better prices to Arabica coffee but ICO´s indicative price was pulled down by Robusta prices. New and "old" growers came to face each other in the market: new growers had an export promotion strategy while old growers were interested in higher prices.

The break up of ICO Agreement started the *liberalisation and privatisation trend.* Grower countries began reducing participation of the State. Important examples of this process were: the reduction to INMECAFE´s functions in México (1982); the elimination of IBC in Brazil (1990); changes in FEDACAFE-Colombia (19-9), the coffee Marketing Board in Uganda, and the "Oficina Nacional de Comercialización de los Productos Básicos in Cameron. Meanwhile roasting and soluble industrial firms were gaining their increasing participation by a continuous concentration process.

Most of the changes in the structure of the chain's governance are located along downstream segments. It has made the chain mostly demand oriented, as shown by the independence obtained by traders and roasters during the crisis of international coffee market from 1987 to 1992, where prices at end markets did not change as import prices did (Daviron, 1994:68).

The coffee chain governance used to a confrontation process between country growers

and commercial houses. But as the market became liberalised, country growers lost their influence and TNCs traders and roasters gained dominion. An important characteristic of the crisis was that coffee warehousing was no more a strategic element.

During the 90's different trends suggested that chain governance system continued towards a renewed dispute between growers and consumer countries. The liberalisation trend was surprised by the emergence of a coffee-producer's cartel ACPC (Association of Coffee Producer Countries) in August 1993. Talbot (1994) suggests a mix of approaches could understand the governance system of the coffee chain: the global commodity chain approach and the regulation approach. The first one emphasises the structure of the global network of production and transactions regarding the production of finished commodities. It highlights the role of transnational corporations (TNC's) as they control R&D and technology innovations, and/or their oligopolist control of distribution networks in the main markets. The second approach focuses on the role of states and multilateral institutions (particularly World Bank and IMF). "They subordinate the national regulatory attempts of periphery and semiperihery states to the global logic of capital using the carrot of access to international credit and the stick of structural adjustment" (Talbot 1994: 14-15). Talbot proposes a synthesis of these perspectives, which he called the regulating the chain approach. It uses the commodity chain as the unit of analysis, but focuses on the roles of states and multilateral institutions in regulating the modes of the coffee commodity chain.

Situation in coffee chain since 1980 is characterised by Talbot, following the first approach, as another step of coffee chain internationalisation in terms of:

- Concentration of coffee roasting TNCs and coffee-importing firms allowed them increase their control over markets in all consuming countries: Five TNCs accounted for well over 60% of sales across all major consuming markets.
- Five of these TNC's are multiproduct conglomerates, and despite the fact that they are the largest coffee manufacturers in the world, coffee is not their main product.

According to the regulation approach Talbot could establish the following features of the governance system's trajectory:

- The concentration of coffee importing and processing by TNCs has gone hand-in-hand with an increasing role they played providing financial capital. Access to capital is crucial for mergers and acquisition strategies, and to finance their huge purchases of coffee as well. At same time large banks and financial houses prefer to deal with the large trading TNCs.
- The financial capital plays an important role in futures market for coffee. Since the beginning 1900's the futures stock market of New York and London has been part of the green coffee world trade. Additionally since 1980's the most important TNCs have increasingly pegged the prices they pay for green coffee to New York or London future prices. As a result TNCs have gained another advantage because these kind of operations require financial expertise they posses. Another important fact is that, the volume of future transactions soared during the 1980's due to commodity funds and conglomerations of financial capital seeking for financial and quick profits.
- The role of multilateral institutions and the reorganisation of peripheral states: Structural Adjustment Programs pushed by the World Bank and IMF did not have

much effect on reducing state regulation on early stages of the commodity chain until the coffee crisis of the early 1990's.

The regulation approach couldn't predict an important feature of the coffee chain during the 90's: The segmentation of the world market, on one hand, industrial coffee products has grown rapidly alongside with the "traditional" trade in green coffee; on the other hand the green coffee trade itself has become segmented as speciality markets are growing in consuming countries. This new kind of trade of industrial coffee products is linked, in part, to the increasing concentration of coffee processing by TNCs in consuming markets. TNCs have expanded their plants or building new ones, strategically located near major ports or intended to attend major markets in different consuming countries. International trade statistics an increase trade in processed coffee products among core consuming countries, as it will be analysed later.

This concentration process has generated a demand for industrialised inputs: large quantities at lowest prices. The supply side response was the adoption of high yielding varieties, where standardisation sacrificed quality. This trend generated a countertrend in the growing process of the specialty market (carefully - tended traditional varieties produced by regions). Those niches are dominated by relatively small export and import firms, which are more likely to trade only in coffee.

The regulating approach couldn't distinguish aspects of the internationalisation of the coffee chain as the internationalisation of agriculture they proposed, because they did not take into account the possibility of different commodities being affected quite differently by the globalisation. According to Talbot, in the case of coffee, because its tropical nature, the impact of globalisation on the structure of the chain has been limited to the upper half of the chain, beginning with the importing of green coffee.

One relevant change in the structure of power in the coffee market was the formation of the coffee cartel ACPC, which in for a period reflected a mechanism of co-operation among coffee-producing countries. However, that cartel disappeared later on.

Summarising, the situation of international coffee chain governance system in the 1990s can be described in the following terms:

a- Monopoly rents are accrued to TNCs, which are operating with global perspective, and have strengthened their position in downstream segments.
b- Grower countries have disputed strategic rents through the ACPC, but their position has been weakened by the market power of TNCs.
c- Resource rents have been renewed from a generic vertical differentiation (Arabica or Robusta coffee) to a more diversified niche of quality (specialty, social, natural coffees).

3. Main innovations in the Costa Rican coffee sector: evolution of the sectoral innovation system

The way in which the coffee sector is organised is dynamic in terms of both the technical and the social organization of interlinkages among cultivation, harvesting, local transportation, processing, overseas transportation, and distribution abroad. In general, the nature of the international coffee market has changed significantly over the

centuries. The control of the market moved away from producers to exporters in the eighteenth century. Later on, in the nineteenth century the control was taken by importers and in the twentieth century to roasters, government institutions, and finally to few vertically integrated multinational firms (Samper, 2001). This kind of transformation has generated relevant changes in the sectoral systems of innovation in the sector. There is a description of the main institutional and technological innovations along the time in this section. There is information about the trajectories of three different issues: the knowledge base, the actors and networks, and the institutions. The evolution of the institutional framework is explained highlighting the main changes in the policies and the sectoral organizations.

3.1 Evolution of the coffee sector in Costa Rica

The coffee sector has played a very relevant role in the Costa Rican Economy. This product linked the economy with international markets through exports to different markets. There has been relevant transformation in the institutional framework, and in the role of different actor along the time. It is possible to identify also relevant technological changes both, in plantations, transport system and processing methods. In general, several factors explain the growing exports of coffee, especially to Europeans countries, from the decade of 1830. The state promoted the production and trade of coffee with incentives as tax exemptions from 1825 and giving property right to farmers growing coffee on uncultivated lands. Local governments also stimulated the cultivation of coffee by assigning lands and distributing coffee trees by free. The state also invested in infrastructure, mainly in the construction of new roads, the rehabilitation of harbours and later on in the construction of rail routes.

The exports to Europe consolidated in the decade of 1840 thanks to a growing world demand. From the beginning, the Costa Rican coffee was classified as a good quality product, getting favourable prices. The advances in navigation, the incentives by the state, a growing group of farmers and some exporters with business vision, gave the sector the possibility to grow. The introduction of new technologies for processing, using wet methods, increased the quality of coffee. From 1843 to 1850 the export costs diminished considerable when the country began exporting directly to Europe. Additionally, the main coffee growers organized trade companies and invested in export processes.

The construction of railways both to Atlantic and Pacific had relevant impacts on the quality of the product, because it take less time and less impacts on the grain that previously was transported in oxcarts. Railroads and ships, by reducing transportation expenses and transit times, gave the producers the possibility to receive a greater share of the final CIF wholesale price. At the same time, consumers abroad enjoyed lower retail prices.

Until 1880s the international market worked as free market, with increasing prices because of the growing consumption in Europe. Normally, European cosignatories and transporters did pay in advance to exporters in Costa Rica, financing in this way the purchases to farmers. In this period, the owners of "*beneficios*" (processing plants) used to buy the coffee cherries and export parchment dry seed. In 1850 there were 76 exporters but 16 of them exported 85% of the coffee.

The social networks and the concentration of power in the coffee sector were closely associated with main processing technologies. "In contrast to the cheaper dry method, which was so extensively and economically used in Brazil,--and used on a much smaller scale in certain more marginal parts of Costa Rica as well—Costa Rica's wet method led to central processing plants (*beneficios)*. They were located either on large farms or in towns and cities, with increasingly technical procedures and attention to quality. Such processing had implications for the manner of harvesting (handpicking only ripe cherries rather than Brazil's more industrial and less discerning style), the development of transportation (first oxcarts, then railroads and trucking), and relations between coffee mill owners and their suppliers of fresh coffee fruit. These 'client' networks were not limited to the purchase of cherries, since private credit has played a major role in structuring the flow of funds and harvests, especially before nationalization of the banking system in 1949 but even afterwards" (Samper, 2001).

There were some relevant changes in the period 1890s – 1920s. From 1894 Brazilian coffee production increased rapidly. The market continued being free, but with some regulations, except for Brazil who decided unilateral actions. Some foreign importers began to have local representatives to buy to *beneficios* who did not export directly. It began some conflicts between planters and owners of *beneficios*. The internal transport from farms to *beneficios* was done by oxcarts and from there to harbours by railways. The fast growing of Brazilian coffee generated over production since 1897 and prices drop. This crisis, together with internal monetary crisis in the Costa Rican economy and an international economic crisis, had impacts on the sector. The crisis finished in 1907-1908.

The number of *beneficios* grew during most of the 19th century then stabilized at the turn of the century at about 200. Later on, in the 20th century, the number decreased as a result of the improved transportation system and some technical improvements facilitating centralization of processing plants. Smaller processing facilities nearly disappeared. At the same time, the amounts processed per agro industrial plant multiplied several times while productivity of labour in wet processing also increased during the 20the century. Supply networks for each coffee mill expanded to cover much larger regions, altering the structural relations among farmers and processing firms, and also the interactions among processors (Samper, 2001).

3.2 Internal regulation in the local coffee market 1920s: creation of the Coffee Office

In addition to the policies to promote production and exports of coffee, the Costa Rican State became playing a key role in the market, generating new rules both for plantation and for processing plants. This kind of intervention was relevant for the definition of the main technologies and to regulate the interaction among farmers and *beneficios*.

Since the late 19th century, Costa Rican farmers were better informed on prices. With more information about international prices, farmers realise about the strategies of joint price setting by the processing and export firms. It was clear the agreement among the main processing firms in the central coffee-producing region to reduce prices in a concerted fashion. Small farmers reacted by rapidly mobilizing and threatening to let their coffee dry on the tree. After few days, they got considerable higher prices. Farmers pushed to eliminate price differentials in certain specific locations, where

quality and recognition abroad allowed exporters to obtain exceptionally high prices. There was an antecedent for price regulation in 1903 when, as a reaction to the intention by processing mills to set a uniform price for all coffees, farmers mobilized and successfully defended their advantage, while also setting a precedent by questioning the current price paid for coffee on the local market (Naranjo, 1999).

In the decade of 1920, larger farmers and owners of processing plants, grouped in the Chamber of Agriculture. They used this organisation as a mechanism to set the domestic purchase price of coffee for all *beneficios*, nationwide. Perhaps more than the price level itself, this joint decision irritated small and medium producers because it effectively stopped them from negotiating better prices for their coffee from competing mills (Samper, 2001). There is evidence on the conflicts among farmers and processing mills for the period 1922 – 1929 but the main conflicts were between 1932 and 1936. Actually, in 1932 was organised an association of producers of coffee, pushing for new laws in order to regulate the interactions among producers and processing mills. The pressure gave results and in 1933 was created the Institute for the Costa Rican Coffee – IDECAFE- (Acuña y Molina, 1991). This Institute was responsibly to regulate relations among growers, processors and exporters, seeking to defuse rising tensions and institutionalize mechanisms to determine distribution of the final price.

In this way the state became playing a new role. Additionally, the farmers asked a new role for the state, by the participation of the state banks in financing the sector. In this way the farmers finished the dependence with respect to the financial mechanisms by processing mills. The most relevant transformation in the sectoral system of innovation was that IDECAFE became in a technical and agronomic institution giving support to increase productivity and quality in the coffee sector and also regulating prices among farmers and processing mills.

3.3 The green revolution in the coffee sector: 1930s – 1950s

The regulations introduced by IDECAFE generated relevant changes in the sector: a clear division of labour among producers and processing mills and a specialization in the different segments of the production chain. As a result, the amount of *beneficios* decreased and in average the amount of coffee processed increased. Some technological changes were introduced to make it possible: there was a tendency towards mechanisation of several labours in the processing mills and there were more centres of store of fresh cherries with better roads. There was a clear interest for cost reduction during this period in the processing mills which explain the tendency towards mechanisation of several tasks, in order to diminish the labour costs.

There was also a technological transition in plantations, moving towards more intensive use of the land and the application of fertilisers, with more use of high Arabic variety of coffee. The planted areas increased significantly.

In 1948 IDECAFE was transformed in the Coffee Bureau, adscript to the Ministry of Economy. This organisation had representatives of farmers, processing mills, roasters and exporters. One of the main functions was to regulate the prices. From this year the state made a more aggressive participation in the credit system for the sector, through the National Bank.

3.4 R&D promoted by Estate agencies and the emergence of cooperatives: 1960s – 1980s

In the decade of 1960 emerge a new kind of actor in the coffee sector: the cooperatives. These organisations group farmers, and give the opportunity of vertical integration. The cooperatives normally have processing mills and several services for the farmers, including technical advisor. One of the main impacts has been the introduction of new actor in the internal trade of fresh coffee, giving better conditions to farmers, who get better prices and part of the profits generated by the processing mills. There is also new regulation for the local trade, coordinated by the "Oficina del Café". With the new agents in the market, the processing mills have to compete with the proportion of payments in advance and with the final prices paid to farmers after selling the processed coffee. In addition, a federation of cooperatives –FEDECOOP- became in one of the main exporter firms.

The Institute of Coffee –ICAFE- previously IDECAFE until 1948 and the Coffee Bureau until 1985- played a very relevant role. ICAFE was created in order to strengthen the legal and administrative tools necessary for regulating relations between coffee producers, processors, exporters and roasters. The Coffee Research Center (Centro de Investigaciones en Café - CICAFE) was set up in May 1977 by the Costa Rican Coffee Institute to develop and disseminate technology relating to the different aspects of coffee production. Building on over 50 years of scientific studies on coffee in Costa Rica, CICAFE carries out research on coffee, particularly through breeding experiments in the field. It also operates a chemical laboratory, provides support for quality control and carries out research. One result was a standardisation of technologies in plantations. Additionally, the Ministry of Agriculture in coordination with CICAFE, developed a efficient system of agriculture extension. As a result, the productivity in farms increased continuously and Costa Rica present the highest productivity in the world. Knowledge became a key factor for competitiveness of the sector in this period.

Another transformation was the continuous advance towards specialised processing mills, which contributed to get better quality and international premium in prices. It continued the technical advance in the processing mills, reducing labour costs and increasing the amount of coffee to process. The technical advance also contributed to increase quality and to very significant cost reductions.

The integration of the chain from planting to processing contributes to better management of the quality issues. One relevant technological change was the introduction of *caturra* and other varieties of coffee with short trees. Most of the exports were to occidental Europe and to gourmet niches in United Estates and Japan.

3.5 Towards gourmet coffee: from 1990s

There are several innovations from 1990s in the coffee sector in Costa Rica along the whole value chain. In the plantation segment the growers introduced the production of organic coffee and new varieties and practices in plantations. In the processing mills there were introduced some environmental improvements in the processes and the use of environmental standards. There was developed a process for vertical integration of the production chain. The national roasters began with the production of gourmet coffee both for national market and for exports and promoted technological change in the

roaster processes and innovation in the commercialization mechanisms, including exports of final product (gourmet coffee) with local trademarks. Another relevant change is a growing relevance of the local market, showing a growing per capita consumption, better quality for local market and different segments of quality and prices. In terms of the export segment there were also some relevant innovations. Some of the more important are the process to export to high quality niches (gourmet coffee), the use of containers, the development of new mechanisms for more efficient transactions, improvements in the systems of trade and the use of indirect marketing mechanisms linked to the growing tourism sector[4]. Some other innovations came from the institutional framework, with new organisations of producers, the transformation of ICAFE in a public but nongovernmental organization and the development of new mechanisms of coordination among different state agencies and private stakeholders.

The main innovations came from the coordinated effort among several key actor of the system of innovation. A key factor has been the effort in R&D by ICAFE and CICAFE. Another relevant factor explaining the relative good innovative performance is the introduction of new environmental regulations for processing mills designed as a result of R&D projects by CICAFE and the processing mills and strictly applied by a coordinated effort among the Health Ministry, the National Electricity Bureau and the Institute for Water and Sewers (AyA). Part of the basic knowledge for improving the processing mills came from the support by international experts giving advice to ICAFE in the R&D projects. The support in R&D by CATIE, a technological university in agriculture issues, was also relevant. It has been also relevant the participation of the Ministry of Agriculture in R&D projects in plantations and in training processes. This ministry also has participated in projects for giving advice to farmers. Another component of the system came from the participation of the Institute for Learning (INA) in training processes.

The cooperatives also contributed to knowledge diffusion thanks to their projects of technological support to the farmers. The attitude of farmers to participate in projects for technical advisor and training was also important. There were some incentives by the Program for improvement of Coffee (PROMECAFE). The access to financial resources both in the national banking system and from cooperation agencies was indispensable for investing in technological change in the processing mills and farms. An agreement among the processing mills to receive only ripe coffee, according with parameters of quality, was also relevant.

There was also an organisational innovation in this period. In 1997 ICAFE pass from a decentralised state agency to a public organization of non State nature, representing the different actors in the coffee sector. This transformation gave more flexibility of functioning to ICAFE and gave the possibility to develop marketing programs. In addition, the institutional change introduced changes in the governance scheme of the sector, giving more power to producers. The representation in the board of this institute for producers passed from 3 of 7 members to 5 of 9. With this change, the exporters lost part of the power. The risk is that the new policies and regulations put poor attention to export issues and concentrate in the producer agenda. The conclusion is that, even with the evolution of ICAFE, there is still and open agenda for improving the regulation

[4] This is a example of catch up of the strategy of farmers in distinct countries which attract tourists to visit the farms and the processing plants as way to generate extra income.

system in the sector, trying to facilitate the innovation processes in the whole value chain. One of the critics by the exporters is that ICAFE is involving in some tasks that should be developed by exclusively by exporters. Actually, ICAFE has several regulations for the export processes which generate inefficiency. Another issue in discussion is that ICAFE is leaving the technical assistance programs, giving the whole responsibility to the Ministry of Agriculture. This could generate some problems in the processes of technological transfer.

In the following sections we develop with more details on the main innovations from the 1990´s.

3.5.1 Towards the specialization of the sector: Markets of gourmet and sustainable coffee.

Product of the last international crisis prices of coffee, initiated in the second semester of 2002, the producer coffee countries decided to reformulate their productive structure. During this crisis, near of 300 00 Central American producers leaved the coffee activities (CEPAL, 2002:5), because of the negative balance among the price paid of the coffee and the producing cost.

Worldwide, organizations like the International Coffee Organization (ICO) and the Food and Agriculture Organization of the United Nation, began promoting the trade of specialized coffee. The new strategy consisted in avoiding or at least reducing the effect of low prices on producers. The transition from conventional coffee production to the specializing one (certified or gourmet coffee), was promoted as an opportunity to differentiate the product and obtain better and sustained prices (FAO, 2004 mentioned by Killian et al, 2005:1).

Following this strategy, Costa Rican producers opted for the production of high quality coffee. The quality, as a commercial and positioning strategy, is conceptualized across two pillars: the high differentiation and the high segmentation (ICAFE, 2004:43). The segmentation strategy is based on positioning the Costa Rican coffee in niches of market in growing, as the gourmet and the sustainable ones. These niches gave an opportunity for diversification of the offer and the possibility to get advantage of new commercial opportunities.

The movement towards productive specialization and international positioning demanded significant changes in the productive national structure. The main internal challenge was to be competitive in the new niches and high quality products, which main characteristic is to be based on intensive in knowledge. ICAFE promoted sectoral policies to incorporate innovations in the productive and commercial area. Very relevant has been the influence of international organizations and firms in introducing this new strategy of high quality niches. For example, Starbucks has had relevant impacts generating this culture of consuming high quality coffee. Responding to this new scenario, there were some innovations to increase quality, some environmental innovations and an institutional innovation. The main result was to focus in the criteria of specialization based on quality instead that on quantity[5].

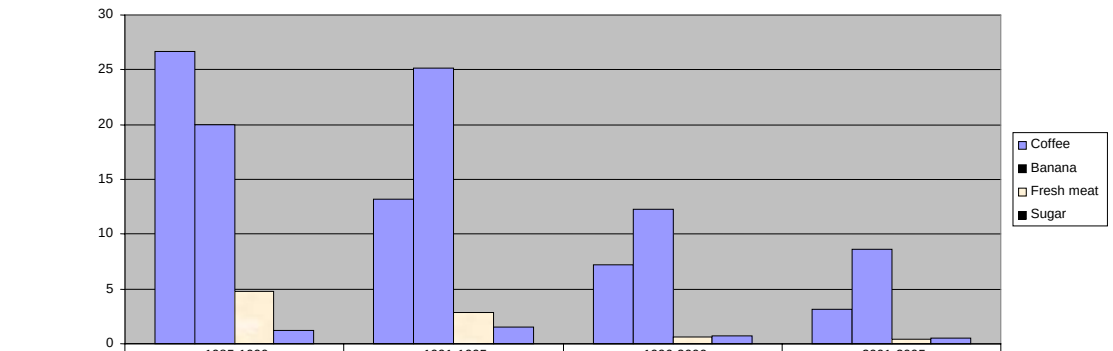
[5] Traditionally, the coffee production in Costa Rica was intensive in the use of agrochemical and was presenting one of the highest productivities in the world.

3.5.2 The quality as a Productive and Commercial innovation

The coffee sector has been very relevant for the Costa Rican economy for its contribution to income and employment generation. Nevertheless, the relative contribution has been reducing. From 1995 to 2006, the value FOB of the coffee exports felt from 417 millions of $US to 225, 8 millions of $US. In percentage terms, the previous information would reflect that for 1995 the sale of coffee contributed with 15 % of the total FOB export value, whereas for the year 2006 was of only 2,75 percentage points. Considering the FOB exports value, in the following graph it is possible observe the economic contribution of coffee activity in comparison with other traditional activities like banana, sugar and fresh meat production.

During the first five year period (1985-1990), coffee was the main economic activity, contributing with about 26 % of the total FOB value. In the following five year periods its contribution declined up to representing 3,11 % for the years 2000-2005. Considering only the agricultural sector, coffee represented 21,1% in 1985 but only 7,81 % in 2005 (ICAFE, 1990-2006). The change came both for a reduction in coffee production, for the increasing use of land for urbanism, and for the increment of the contribution of other products. In 1990 Costa Rica grew 115 000 sowed hectares of coffee, but in 2006, according to ICAFE information, only 97 614 hectares were cultivated. The trend in the sowed area is shown in the following graph.

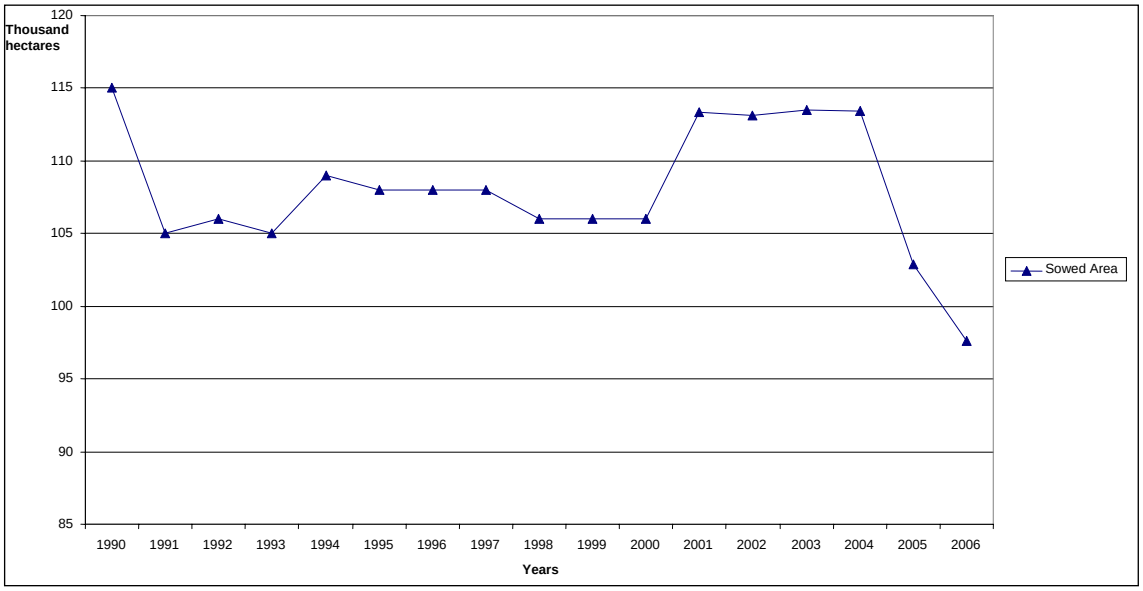
Graph 1 Costa Rica: Percentage participation in the FOB value of exports for principal products (for five year periods 1985-2005)



	1985-1990	1991-1995	1996-2000	2001-2005
Coffee	26,67	13,2	7,24	3,11
Banana	19,93	25,12	12,27	8,57
Fresh meat	4,73	2,8	0,62	0,4
Sugar	1,23	1,48	0,75	0,52

Source: BCCR, 2007; ICAFE, 1990-2006

Graph No 2.
Costa Rica Coffee Sowed Area



Source: ICAFE; 1990-2005; FAOSTAT; 2007.

But, according to ICAFE, the reduction in the sowed area reflects the focus on quality instead than on quantity (ICAFE, 2005:29). A parallel result is that the productivity declined but with increments in the international differential of prices obtained, which has been higher than the ones for the regional competitors.

At Central American level, the countries having the minor sowed area have gotten higher productivity. It is the case of Honduras with an area of 182, 300 it hectares (has) and productivity of 0, 87 tm/has and Costa Rica with a total area of 115 000 and a productivity of 0,85tm/ha. It can be the result of excellent conditions of soils and altitude, combined with better levels of modernization and technical assistance offered to the producers (Castro, 2004: 45).

At the end of the decade of 1980´s Costa Rica used to lead worldwide productivity with 36 fanegas (ff) per hectare. Nowadays, Vietnam is the country with the major world productivity. For the year 2004, Vietnam obtained an average productivity of 31,98 ff/ha, in comparison to the 25,75 ff/ha that Costa Rica obtain for the same one. Nevertheless, inside the group of arabican coffee producing countries, Costa Rica still leads in terms of productivity. In the following graph, we are present a comparison of the productivity for hectare of some producing countries for the same year.

One important indicator for quality is the differential obtained with respect to international prices. The Costa Rican coffee has been in a leader position, getting a sustained high differential, as it is showed in the next table.

Table No 1
Average productivity in some selected countries
(Crop 2003-2004)

Country	Productivity (FF/ha)
Vietnam	31,98
Costa Rica	25,75
Colombia	23,82
Brasil	22.34
Guatemala	20,6
Perú	15
México	9,24

Source: ICAFE, 2005:35

Table No2
Differential in coffee prices obtained by selected ICO countries members
(Total exports all destination)
(1999-2004)

Country	1999	2000	2001	2002	2003	2004
Kenia	29	-4,1	13,3	25,8	-29,4	36,1
Costa Rica	10	11,9	10,3	14,1	11,6	9,6
México	-1,7	3,9	12	13,9	10,8	4,8
Colombia	5,2	10,3	12,4	11,8	5,7	3,7
Guatemala	-7,7	0,6	2,2	5,9	-2,3	-0,1
Nicaragua	6	6,9	4,3	10,8	8,5	-0,6
El Salvador	-4,5	1,7	3,3	-0,9	-1,3	-6
Perú	-19,5	-17,5	-2,9	-1,7	-6,4	-6,2
Honduras	-5,1	-0,4	-3,1	-1,4	-4	-6,8
Brasil	-22,4	-14,2	-8	-16,1	-16,1	-17,5

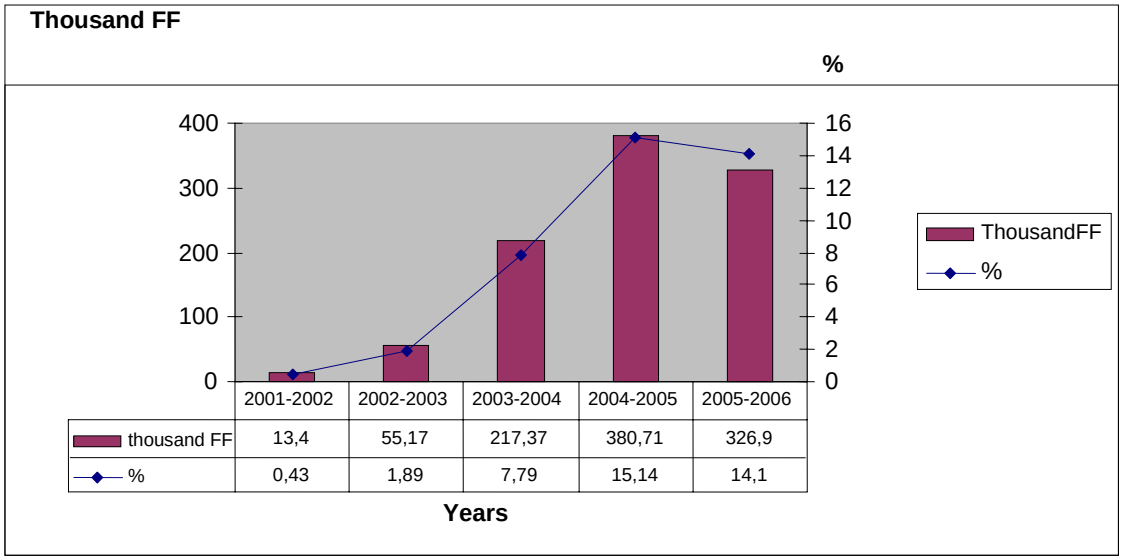
∗ In US$ / quintals

Source: OIC y NYBOT, mentioned by ICAFE, 2005:35.

It is important emphasize that of the year 1999 to 2004, Costa Rica occupied the first and second position in differential of prices, considering the 10 main producers of Arabic coffee. Undoubtedly, this positioning has been achieved thanks to research and permanent development of projects that add value to quality concept from the seed up to cup, which has been recognized by the international buyer. A related indicator is the relevance of sales in gourmet markets. This behavior is presented in the following graph. There is an increment of the participation of gourmet coffee from about 0,43% in 2001-2002 crop to 14,1% for the 2005-2006 crop.

ICAFE attributes the increase in the market share of gourmet coffee niches, to the processes of investigation and development and modernization of the activities production, marketing and exportation of coffee. In a medium term, it is expected that the special dried process, the production of organic coffee, the quality control, the promotion of Costa Rican coffee, the exportation with own national brands elaborated in small coffee miller, besides the use of certifications (ICAFE, 2005:35), will help to raises the volume of grain that takes part in these gourmet niches.

Graph 3
Differentiate coffee production in Costa Rica
Coffee Berry Fanegas
(Crops 2001-2006)



Source: Own elaboration with ICAFE, 2005 and ICAFE; 2006 information.

3.5.3 Environmental innovations

There are two main innovations aimed to improve the environmental performance of the coffee sector. The first ones is the modernization of coffee factories, which allowed these companies a minor utilization of water and energy. The Inter-institutional Agreement for Cooperation among producers and authorities was the motivator of this innovation. The second innovation came from relevant changes in the environmental legislation developed in the country, which aimed a rational use of water and energy in a framework for the introduction of the cleaner technologies.

The Interinstitutional Agreement for Cooperation was an important framework to introduce changes and improve the environmental performance of coffee mills. In the ends of eighties decade and the beginning of the nineties, the industry of the coffee was generating near of 60 % of the organic industrial load spilt in the waters of the rivers. Additionally, the coffee industry contributed with 15 % of CO2 emission of the national

industry, the consumption of 8 % of electricity and the production of 360.000 tons of flesh in only 4 or 5 months. This undoubtedly had a very negative effect for the environment in spite of the economic and social contribution that the sector realizes (Chacón, 1997 mentioned by Ruiz y Orozco, 2001:38)

Before this situation and associate with the increase of buyer international requirements to produce a coffee with minor environmental impact, businessmen related to the sector decide to implement a voluntary program to gradually reduce the pollution by mill processes. The result of this initiative was the Interinstitutional Agreement for Cooperation, giving the space in 1992 for an alliance between the coffee sector, the Costa Rican Institute of Coffee (ICAFE), the State Agency incharged pf water management -Instituto Costarricense de Acueductos y Alcantarillados (AYA)-, the state agency for regulation of public services -Autoridad Reguladora de los Servicios Públicos (ARESEP)- and the Health Ministry (MINSA).

The general objective of the program was to radically reduce the waste water coming from the coffee industry and contaminating the rivers. The strategy was to reduce waste water and reduce the residues at the origin point (ICAFE, 1997). The goal was to reduce in 80 % the pollution caused by the agroindustry.

According to Alpizar (2005), the program promoted the utilization of cleaner technologies for decontamination waters and for the treatment of solid waste in tanks of sedimentation, as well as the reduction in the use of the water. The program followed a preventive strategy in the managing of the pollution raised in four stages (Orozco and Ruiz, 2001:39):

- *Step I:* Reduction of the use of water in milling activities. Before the signature of the Agreement, a normal coffee miller was using 15,5 liters of water for kg of mill fruit, being established like obligatory to reduce this consumption to a fourth part (3,8 liters) for kg of fruit.

- *Step II:* Recovery of the small solid of the waste miller water. In this stage, there was obligatory the use of different kind of filter constructed in stainless steel by wires in trapezoidal form, which allow the recovery of solid major 0.75 mm of thickness.

- *Step III:* Reduction of 50 % of the suspended solid in the water. The construction of tanks for sedimentation was executed in this stage. There were introduced also small lagoons of moods for the disposition of the sediments. Likewise, the pulping is established like obligatorily in dry of the cherries and the not hydraulic transport of the flesh.

- *Step IV:* Anaerobic treatment of the waters. It was established the reduction of pollutants in 80 % in terms of chemical oxygen demand and of biochemical demand of oxygen.

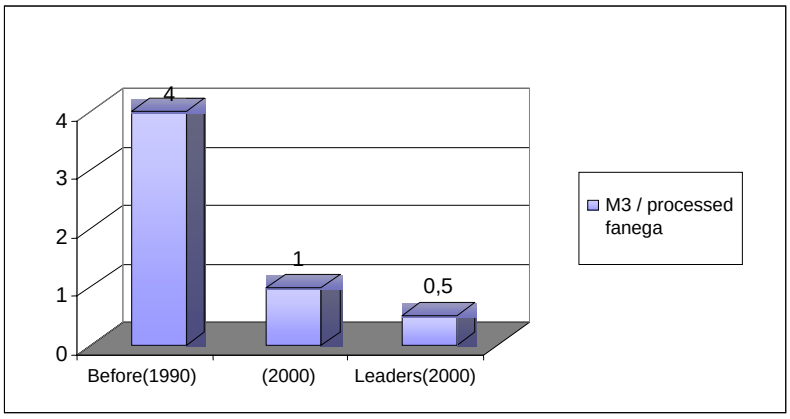
The application of the Agreement has had positive effects in the country. As result of the agreement, the coffee sector has invested near of 11 000 million colons for the treatment of the waste water (CEPAL, 2001: 52). These investments have allowed

advance significantly in the restructuring of coffee mills. A significant result was the reduction of the water consumption and the pollution generated in the mills.

The following figure illustrates the significant advance related to water consumption. Before the agreement, the coffee miller were using 4 m3 per fanega. With the agreement the goal was to reduce the consumption to 1 m3 per fanega. In 2002 some of the mill companies were able to reduce water consumption to lower levels than 0,5 m3 per fanega.

Graph No 4

Water consumption in the Costa Rican coffee mills (1990-2001)



Source: CEPAL, 2002.

3.5.4 Institutional innovation: The new Role of the ICAFE and the role of R/D

The role of ICAFE has evolved drastically along the time. Initially, the institute was created by law to protect the interests and guarantee an equitable regime between the sectors involved in the production of coffee. In 1948, the Institute of Defense transforms in the Office of the Coffee, as an organization semiautonomous and assigned to the Department of Economy. This reform changed this institute into a governmental organism, controlling the interactions in the coffee sector.

With the growth of the sector and the complex activity of the international market, in 1985, the Office of the Coffee was transformed into the Costa Rican Institute of Coffee (ICAFE), aimed to regulate relations between producers, benefactors, exporters, and roasters. A last transformation, in 1997, turns the ICAFE into a nongovernmental public entity, with juridical legal status and own patrimony, and wide possibilities to sign contracts and to dictate acts of conformity according to the attributions that indicates the law (ICAFE; 2007). The evolution of ICAFE has continuously provided the sector with an adequated institutional framework, facilitating innovation processes in the sector.

One of the main contributions by ICAFE has been the generation of significant research and development processes, organized by the Centre for Research in the coffee sector (CICAFE). This is one of the main factors explaining the high quality and productivity

reached by the coffee sector in Costa Rica. As mentioned, CICAFE carries out research particularly through breeding experiments in the field. This research centre also operates a chemical laboratory and provides support for quality control. One of the main results was a standardisation of technologies in plantations, which contributed to increase both quality and productivity in the sector.

Cooperation among CICAFE, ICAFE, the Ministry of Agriculture and the producers, had positive impacts in technological diffusion. The processes used to begin with research and development projects coordinated by the three organizations and usually implemented by CICAFE, continuing with a coordinated effort for technological transfer. Training as the key factor for human resources improvement has been a relevant strategy along the time.

4. Conclusions: evolution of the sectoral innovation system

In this paper we analysed the evolution of the coffee sector in Costa Rica, considering the trajectories of different key components of the system of innovation, as the knowledge base, the actors and networks, and the main institutions. The evolution of the institutional framework was explained highlighting the main changes in the policies and the sectoral organizations.

The key actors in the knowledge base of the sector have changed along the time. When the coffee sector began developing in Costa Rica, most of the knowledge base was developed by foreigners, especially from the importer countries. This was clearly a catching up stage. In the first phase, the State gave different incentives and basic support to promote the cultivation of coffee. But later on, the State has had a growing contribution to the knowledge base, promoting R&D along both in the cultivation and in the processing phases of the production chain. The diffusion of knowledge has been a function mainly of State organizations but from the 1960s also of the cooperatives of farmers. Nowadays the cooperatives process about 39% of the grain production in the country. The universities have had a poor contribution both in generation and in diffusion of technological knowledge. The knowledge on markets and marketing strategies was concentrated mainly in importer countries, but the incursion by ICAFE in these issues, and the direct participation of the cooperative sector and other exporters, has also contributed to generate local expertise.

Networking has also evolved. The kind of interaction among farmers and processing mills changed along the time. From the decade of 1920s, the State has played a role regulating these interactions, especially for the definition of prices. From the 1990s, new kind of interactions was possible thanks to coordination among governmental and non governmental organisation among them and with the different actor along the production chain.

Financial mechanisms were very limited for many decades, depending on payments in advance from the importers to the exporters and from them to the rest of actors downstream. But early in the XX century the State had a growing participation through national banks.

Considering the concept of catch up for the analysis of an international dimension on technology transfer between countries, we can argue that Costa Rica move from a

catching up position towards an international leadership in many technological issues. The continued investment in R&D to improve the different phases of the production chain made the country leader in several technologies that improved the performance of the sector. The country has also developed in some other technological components by adapting, debugging and improving technologies and competencies developed in some other countries. But still so, is reasonable to argue that nowadays Costa Rica is a leader country in knowledge generation for the coffee sector. The strategy to concentrate in high quality and well paid segments of the market is a good indicator of that. The highest productivity in the world in plantations is also a good indicator of the leading condition of the country.

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